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(54) Annular heat exchanger.

(57) A heat exchanger having a plurality of heat exchanging units (37,38) for different fluids to be cooled, and a blower (22) around which the heat exchanging units (37,38) are arranged. Each heat exchanging unit (37,38) may include tank chambers (24 - 27) to which a fluid inlet pipe (28,29) and a fluid outlet pipe (30,31) are connected, respectively, tubes (33,34) connected between the tank chambers (24-27) and fins (35,36) attached to the tubes (33,34). The heat exchanging units (37,38) are arranged concentrically with each other around the axis (20) of the blower (22).

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FIG. 3

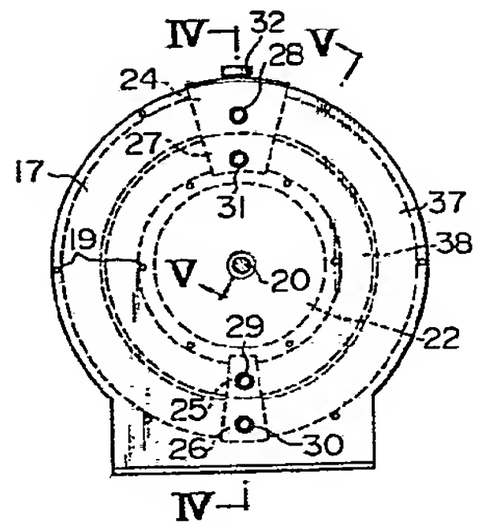
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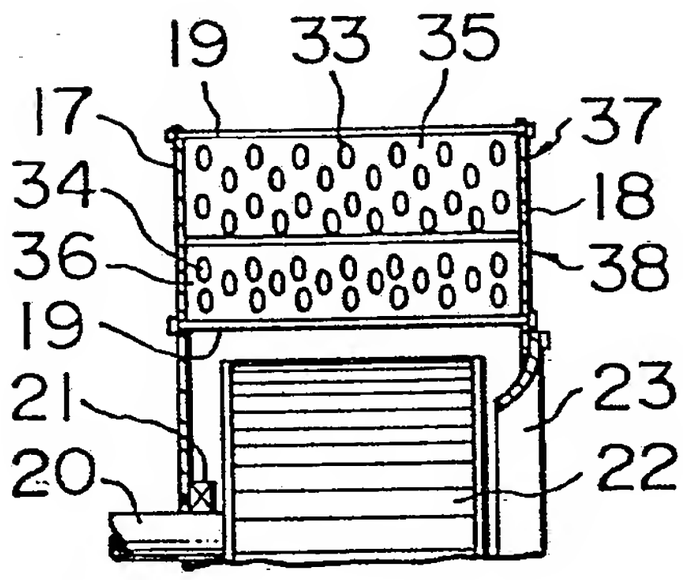
FIG. 5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ANNULAR HEAT EXCHANGER

BACKGROUND OF THE INVENTION

The present invention relates to an annular heat exchanger having a plurality of annular heat exchanging units through which different fluids are circulated to make heat exchange with air blown by a centrifugal blower around which the heat exchanging units are arranged.

Construction vehicles and machineries are provided with a heat exchanger for cooling different kinds of fluids such as cooling water for cooling the engine, working fluid of hydraulic equipments mounted on the vehicle or machinery, lubricating oil of the engine and so forth.

Typical conventional heat exchanger for the purpose described above incorporates a combination of a plurality of heat exchanging units for different fluids and an axial blower. This conventional heat exchanger, however, generates noise of high level to cause annoyance. In order to avoid this problem, recently, there has been proposed an annular heat exchanger in which annular heat exchanging units are combined with a centrifugal blower. In this known annular heat exchanger, the heat exchanging units are arrayed in the axial direction of the centrifugal blower such that each heat exchanging unit surrounds the centrifugal blower.

Although the level of the noise is lowered considerably, this heat exchanger still involves various problems or drawbacks.

Namely, as will be described later in more detail with reference to the drawings, it is not possible to obtain an equal cooling efficiency for all heat exchanging units because the air is not uniformly distributed to all heat exchanging units. In addition, the cooling power of each heat exchanging unit is impractically small because each unit receives only a part of the air blown by the blower. Furthermore, the size of the heat exchanger as a whole is inevitably increased when three or more heat exchanging units are incorporated, because it is necessary to preserve the space for the pipes for introducing and discharging the fluid into and out of the heat exchanging unit disposed at the axially mid portion of the heat exchanger.

SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide an annular heat exchanger in which the heat exchanging units can operate substantially at an equal level of cooling efficiency and at high cooling power, while reducing the size of the heat exchanger as a whole.

To this end, according to the invention, there is provided an annular heat exchanger having a blower and a plurality of heat exchanging units for different fluids

and arranged around the blower, characterized in that the heat exchanging units are disposed concentrically with the axis of the fan.

The above and other objects, as well as advantageous features of the invention will become more clear from the following description of the preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an illustration of a conventional annular heat exchanger;

Fig. 2 is a sectional view taken along the line II-II of Fig. 1;

Fig. 3 illustrates an annular heat exchanger constructed in accordance with a first embodiment of the invention;

Fig. 4 is a sectional view taken along the line IV-IV of Fig. 3;

Fig. 5 is a sectional view taken along the line V-V of Fig. 3;

Fig. 6 is a sectional view taken along the line VI-VI of Fig. 4;

Fig. 7 illustrates an annular heat exchanger constructed in accordance with a second embodiment of the invention;

Fig. 8 is a sectional view taken along the line VIII-VIII of Fig. 7;

Fig. 9 illustrates an annular heat exchanger

constructed in accordance with a third embodiment of the invention; and

Fig. 10 is a sectional view taken along the line X-X of Fig. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before turning to the description of the preferred embodiments of the invention, a description will be made hereinunder as to the drawbacks of the prior art with specific reference to Fig. 1 which is an end view of a known annular heat exchanger and Fig. 2 which is a sectional view taken along the line II-II of Fig. 1.

Referring to Figs. 1 and 2, a heat exchanger of the prior art has sector columnar tank chambers 1 to 4. The tank chambers 1 and 4 are separated from each other by a partition wall 5, while the tank chambers 2 and 3 are separated from each other by a partition wall 6. The tank chambers 1 and 2 are provided with inlet pipes 7 and 8, respectively, while the tank chambers 3 and 4 are provided with outlet pipes 9 and 10, respectively. A cap 11 is provided on the tank chamber 1. The tank chambers 1 and 3 are connected to each other by annular tubes 12. Similarly, the tank chambers 2 and 4 are connected to each other by annular tubes 13. Fin plates 14 are attached to the annular tubes 12, 13 and are arranged radially. The annular tubes 12 and the fin plates 14 in combination constitute

a first heat exchanging unit 15 while the annular tubes 13 in cooperation with the fin plates 14 constitute a second heat exchanging unit 16. The first and the second heat exchanging units 15 and 16 are arrayed in the axial direction. Side walls 17 and 18 are secured by means of bolts 19 to both sides of the tank chambers 1 to 4. A reference numeral 20 designates a shaft extending through the side wall 17 and connected to a prime mover (not shown). A seal member 21 is secured to the side wall 17 to provide a seal between the shaft 20 and the side wall 17. The shaft 20 is connected at its other end to a centrifugal blower 22 which is surrounded by the heat exchanging units 15 and 16. A reference numeral 23 denotes a bell mouth provided in the side wall 18.

In this annular heat exchanger, two kinds of liquids are circulated through respective heat exchanging units 15, 16 to make heat exchange with air which is blown by the centrifugal blower 22 driven by the prime mover through the shaft 20. Namely, a first and a second fluids to be cooled is supplied into the tank chambers 1 and 2 through the inlet pipes 7 and 8, respectively. The fluids then flow toward the tank chambers 3 and 4 through respective annular tubes 12 and 13, so that the heat possessed by the fluids are radiated from the plate fins 14 attached to the annular tubes 12 and 13.

As the centrifugal blower 22 operates, the

cooling air is induced through the bell mouth 23 and is deflected orthogonally toward the heat exchanging units 15, 16 to flow through the latter. Therefore, the velocity of air flowing through the axial end portion adjacent to the side wall 18 is smaller than that flowing through the axial end adjacent to the side wall 17. Namely, since the cooling air flows through the heat exchanging units 15, 16 at different velocities, it is not possible to equalize the cooling efficiencies of both heat exchanging units. In addition, each of the heat exchanging units 15 and 16 cannot receive whole part of the air induced through the bell mouth 23. In other words, a part of the air induced through the bell mouth 23 is made to flow through the heat exchanging unit 15 solely while the remainer of the air induced through the bell mouth is made to flow through the other heat exchanging unit 16 solely. Therefore, the heat radiation efficiency in each unit is comparatively low.

In the case where the heat exchanger has three or more heat exchanging units, it is not possible to arrange the inlet pipe and outlet pipe of the central heat exchanging unit in parallel with the shaft 20, unless the tank chamber of the central heat exchanging unit solely is projected radially outwardly or the inlet and outlet pipes are bent at 90°. In such a case, the maximum diameter of the annular heat exchanger is increased impractically.

Under these circumstances, the present invention provides an annular heat exchanger in which the cooling efficiencies of all heat exchanging units are equalized and the heat radiation efficiency of each heat exchanging unit is improved, without being accompanied by an increase of the maximum outside diameter of the annular heat exchanging unit, as will be understood from the following description of the preferred embodiments.

Fig. 3 shows an annular heat exchanger constructed in accordance with a first embodiment of the invention, Fig. 4 is a sectional view taken along the line IV-IV of Fig. 3, Fig. 5 is a sectional view taken along the line V-V of Fig. 3 and Fig. 6 is a sectional view taken along the line VI-VI of Fig. 4.

Referring to these Figures, the heat exchanger of the first embodiment has section-shaped columnar tanks 24 to 27. For instance, tank chambers 24 and 27 are constructed as a unit and are separated from each other by a partition wall. Similarly, the tank chambers 25 and 26 may be constructed as a unit and separated from each other by a partition wall.

Numerals 28 and 29 denote inlet pipes connected to the tank chambers 24, 25, while numerals 30 and 31 denote outlet pipes connected to the tank chambers 26, 27.

The tank chamber 24 is provided with a cap 32. The tank chamber 24 and the tank chamber 26 are connected to each other by annular tubes 33, while the tank

chambers 25 and 27 are connected to each other by annular tubes 34. Fin plates 35 and 36 are attached to annular tubes 33 and 34 and are disposed radially. The annular tubes 33 and the plate fins 35 in combination constitute a first heat exchanging unit 37, while a second heat exchanging unit 38 is constituted by annular tubes 34 and the fin plates 36. The first and the second heat exchanging units 37, 38 are arranged concentrically with each other.

In operation, two different liquids to be cooled are introduced into the tank chambers 24, 25 through the inlet pipes 28, 29 and are then sent to the tank chambers 26, 27 through the annular tubes 33, 34. Meanwhile, the centrifugal blower 22 is driven through the shaft 20 to generate a flow of air which carries away the heat of the liquids from the plate fins 35, 36 attached to the annular tubes 33, 34 in which the liquids to be cooled are circulated.

Fig. 7 shows an annular heat exchanger constructed in accordance with another embodiment of the invention, while Fig. 8 is a sectional view taken along the line VIII-VIII of Fig. 7. Referring to these Figures, the annular heat exchanger of this embodiment has annular columnar chambers 39 to 42. The tank chambers 39 and 40 are provided with inlet pipes 43, 44, while the tank chambers 41, 42 are provided with outlet pipes 45, 46. The tank chamber 39 is provided at its top portion with a cap 47. The tank chambers 39 and 41

are connected to each other through straight tubes 48, while the tank chambers 40 and 42 are connected to each other by means of straight pipes 49. Annular plate fins 50 and 51 are attached to the straight tubes 48, 49. The straight tubes 48 and the plate fins 50 in combination constitute a first annular heat exchanging unit 52, while the straight tubes 49 and the plate fins 51 constitute a second heat exchanging unit 53. The heat exchanging units 52 and 53 are arranged concentrically with each other.

In operation, two different liquids to be cooled are introduced into the tank chambers 39, 40 through the inlet pipes 43, 44 and are sent to the tank chambers 41, 42 through the straight tubes 48, 49, respectively. Meanwhile, the centrifugal blower 22 is driven through the shaft 20 to produce flow of air which carries away the heat of the liquids from the plate fins 50, 51 attached to the straight tubes 48, 49 through which the liquids to be cooled are circulated.

Fig. 9 illustrates a still another embodiment of the invention while Fig. 10 is a sectional view taken along the line X-X of Fig. 9.

Referring to these Figures, the heat exchanger of this embodiment has about semicircular columnar tank chambers 54 to 57 and circular columnar tank chambers 58, 59. Inlet pipes 60 and 61 are connected to the tank chambers 54, 55, respectively, while outlet pipes 62, 63 are connected to the tank chambers 56, 57. The tank

chamber 54 is provided at its top portion with a cap 64. The tank chambers 54, 56 are connected to the tank chamber 58 through straight tubes 65, while the tank chambers 55, 57 are connected to the tank chamber 59 through straight tubes 66. Annular plate fins 67, 68 are attached to the straight tubes 65, 66, respectively. The straight tubes 65 and the plate fins 67 in combination constitute a first annular heat exchanging unit 69, while the straight tubes 66 and the plate fins 68 in combination constitute a second annular heat exchanging unit 70. The heat exchanging units 69 and 70 are arranged concentrically with each other.

In operation, two different liquids to be cooled are introduced into the tank chambers 54, 55 through inlet pipes 60, 61 and are sent to the tank chambers 56, 57 through the straight tubes 65, 66, tank chambers 58, 59 and the straight tubes 65, 66. Meanwhile, the centrifugal blower 22 is driven through the shaft 20 to generate a flow of air which carries away the heat of the liquids from the plate fins 67, 68 attached to the straight tubes 65, 66 through which the liquids are circulated.

In this case, it is possible to dispose the inlet pipes 60, 61 and the outlet pipes 62, 63 at the same side of the heat exchanger, as will be clearly seen from Fig. 10.

Although the invention has been described through its preferred forms, the described embodiments

are not exclusive and various changes and modifications may be imparted thereto without departing from the scope of the invention.

For instance, the annular form of the heat exchanging units is not essential and the heat exchanging units can have various other cross-sections such as oval cross-section, rectangular cross-section or other polygonal cross-section. It is also possible to provide three or more heat exchanging units although the described embodiment has only two heat exchanging units. In such a case, the size of each heat exchanging unit can be determined as desired in proportion to the necessary cooling capacity. The plate fins used in the described embodiment can be substituted by corrugated fins to constitute, in combination with the tubes, the heat exchanging unit. Other types of heat exchanging units can be used insteadly of the heat exchanging unit mentioned above. Also, the direction of flow of fluids in the illustrated embodiments are not exclusive.

Although a single suction centrifugal blower is used in the described embodiments, it is possible to use double suction centrifugal blowers or other types of blowers such as axial-flow type blower. In the case where a single suction centrifugal blower is used, the air may be induced from the same side as the driving shaft. In the described embodiments, the blower is supported externally and driven by a prime mover mounted at the outside of the heat exchanger. It is, however,

possible to support the blower at its one or both sides by bearing or bearings attached to the side wall or walls of the heat exchanger or to attach the prime mover such as a hydraulic motor, electric motor or the like directly oneof theside walls. Although in the described embodiment the cooling air is blown from the central portion of the heat exchanger radially outwardly, it is possible to arrange such that the air is directed radially inwardly.

As has been described, in the heat exchanger of the invention, a plurality of heat exchanging units are arranged concentrically so that the heat exchanger units receive the cooling air at an equal rate even when there is any uneven flow velocity distribution in the axial direction, to ensure equal cooling efficiency of all heat exchanging units. In addition, each heat exchanging unit can operate at a high heat radiation efficiency because each heat exchanging unit can receive the whole part of the cooling air blown by the blower.

It is also to be noted that, when three or more heat exchanging units are mounted in a single heat exchanger, it is possible to extend the inlet and outlet pipes connected to the central heat exchanging unit in parallel with the shaft of the blower, so that it is not necessary to project the tank chamber of the central heat exchanging body radially outwardly. Namely, it is possible to minimize the maximum outside diameter of the heat exchanger as a whole.

In the heat exchanger of the invention, the heat exchanging units may be disposed taking into account the order of necessity for the cooling such that the heat exchanging unit for the liquid having the highest demand for cooling is disposed at the radially innermost portion of the heat exchanger.

WHAT IS CLAIMED IS:

1. A heat exchanger comprising a blower and a plurality of heat exchanging units for different fluids to be cooled arranged around said blower, characterized in that said heat exchanging units (37, 38) are disposed concentrically with the axis (20) of said blower (22).

2. A heat exchanger as claimed in claim 1, wherein each of said heat exchanging units (37, 38) has an annular shape.

3. A heat exchanger as claimed in claim 1, characterized by comprising annular tubes (33, 34) connected between the fluid inlet (28, 29) and a fluid outlet (30, 31) of each of said heat exchanging units (37,38) and fins (35, 36) arranged in a heat exchanging relation to said tubes (33, 34), said inlet (28, 29) and outlet (30, 31) are arranged in parallel with the axis (20) of said blower (22).

4. A heat exchanger as claimed in claim 1, characterized by comprising two or more tank chambers (39 - 42) including a tank chamber (39, 40) connected to the fluid inlet (43, 44) of each heat exchanging unit (52, 53) and a tank chamber (41, 42) connected to the fluid outlet (45, 46) of each heat exchanging unit (52, 53), tubes (48, 49) connected between said tank chambers (39- 42) and disposed in parallel with the axis (20) of said blower (22), and fins (50, 51) arranged in heat exchanging relation to said tubes (48, 49).

5. A heat exchanger as claimed in claim 1, characterized by comprising annular tank chambers (39 - 42) connected to the fluid inlet (43, 44) and fluid outlet (45, 46) of each heat exchanging unit (52, 53), respectively, tubes (48, 49) connected between said tank chambers

(39 - 42) and extending in parallel with the axis (20) of said blower (22), and fins (50, 51) arranged in heat exchanging relation to said tubes (48, 49).

6. A heat exchanger as claimed in claim 1, characterized by comprising about semicircular tank chambers (54 - 57) connected to the fluid inlet (60, 61) and fluid outlet (62, 63) of each heat exchanging unit (69, 70), an annular tank chamber (58, 59) connected to said about semicircular tank chambers (54, 56; 55, 57) through tubes (65, 66) disposed in parallel with the axis (20) of said blower (22), and fins (67, 68) arranged in heat exchanging relation to said tubes (65, 66).

FIG. 1 PRIOR ART

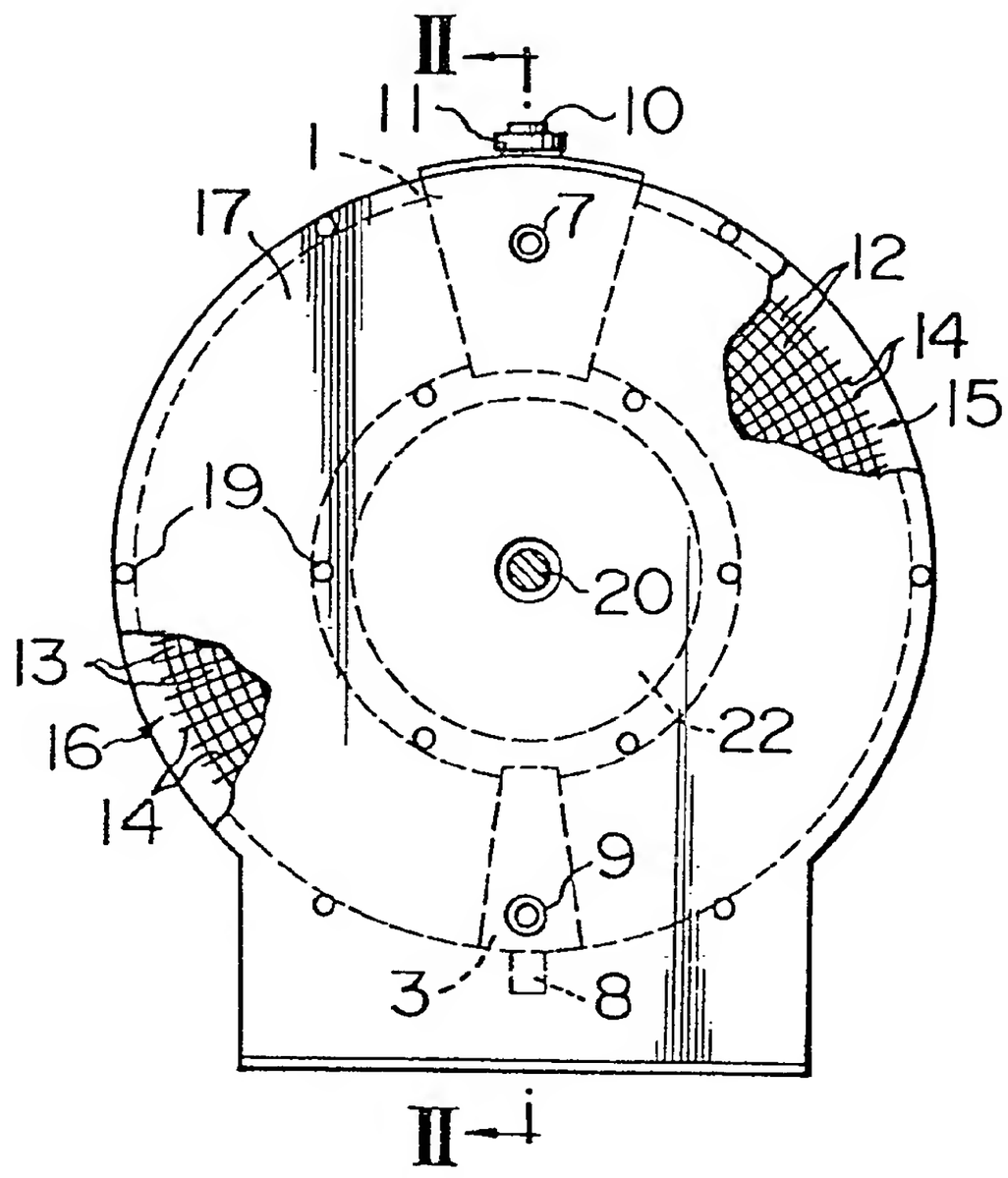

FIG. 2 PRIOR ART

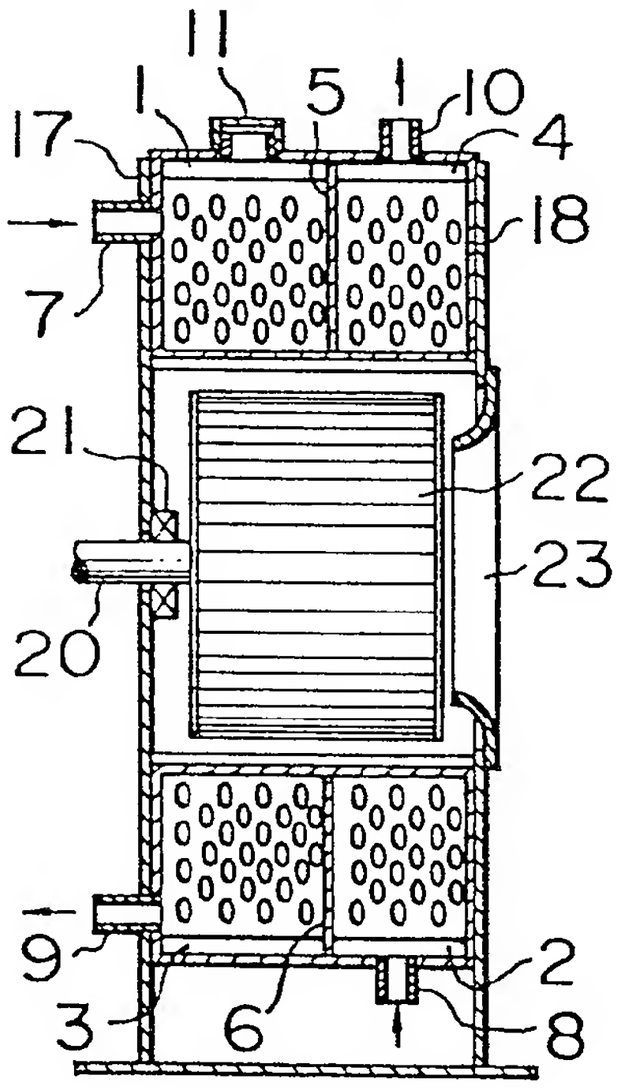

FIG. 3

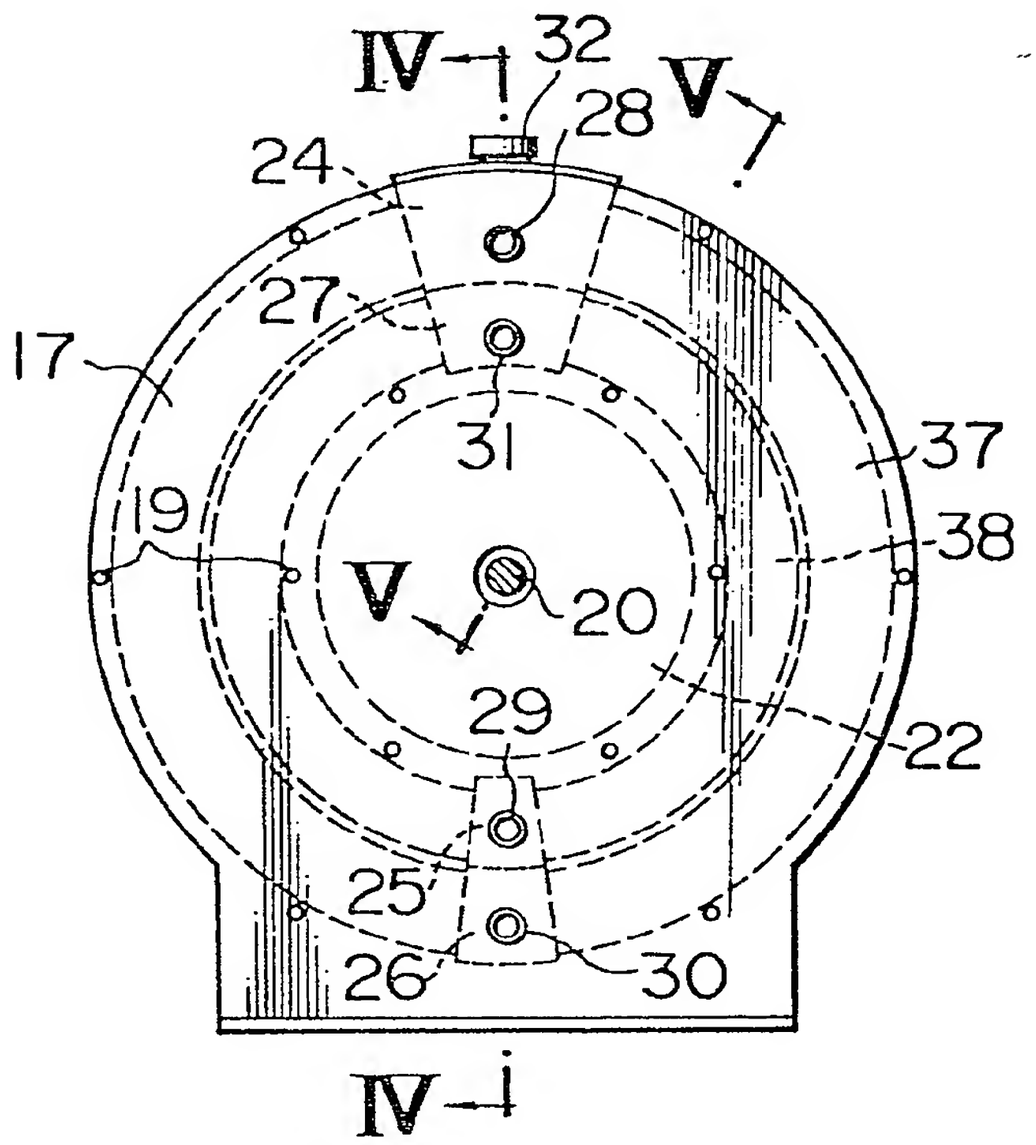
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FIG. 4

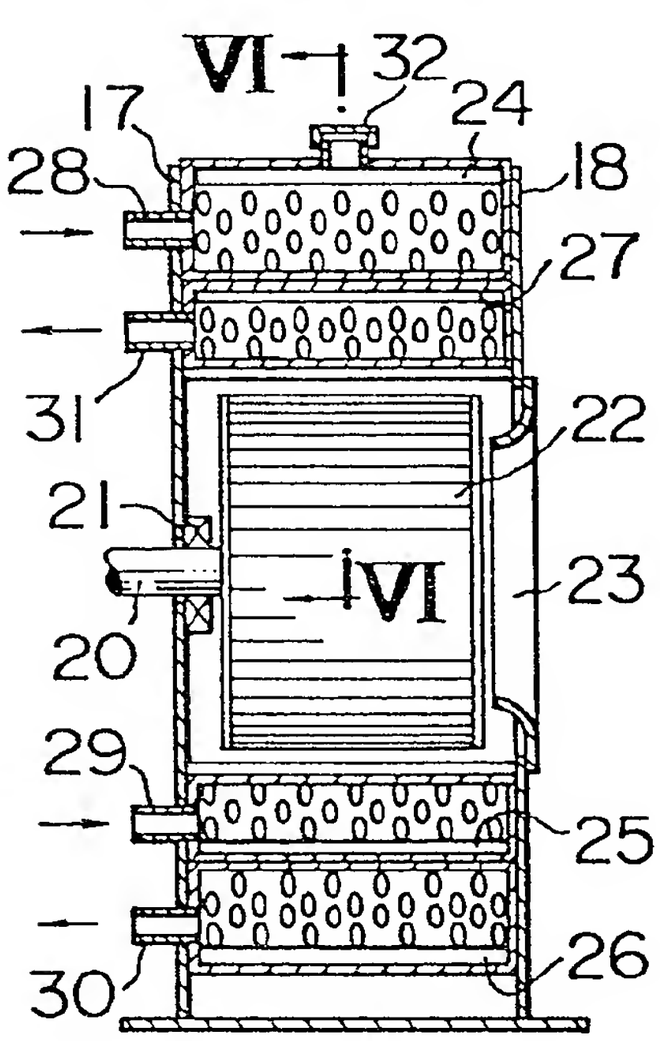
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FIG. 5

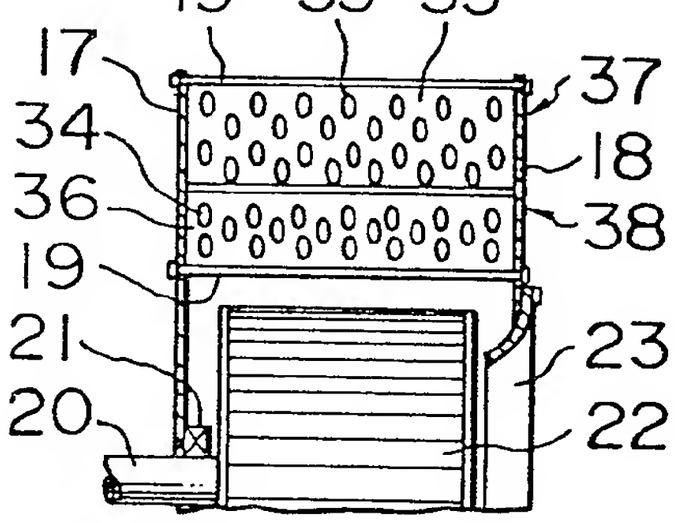
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FIG. 6

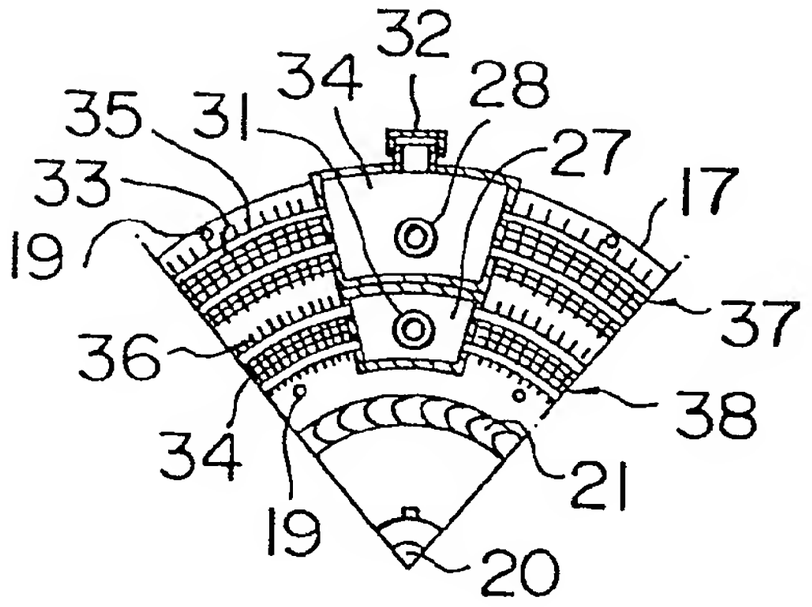
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FIG. 7

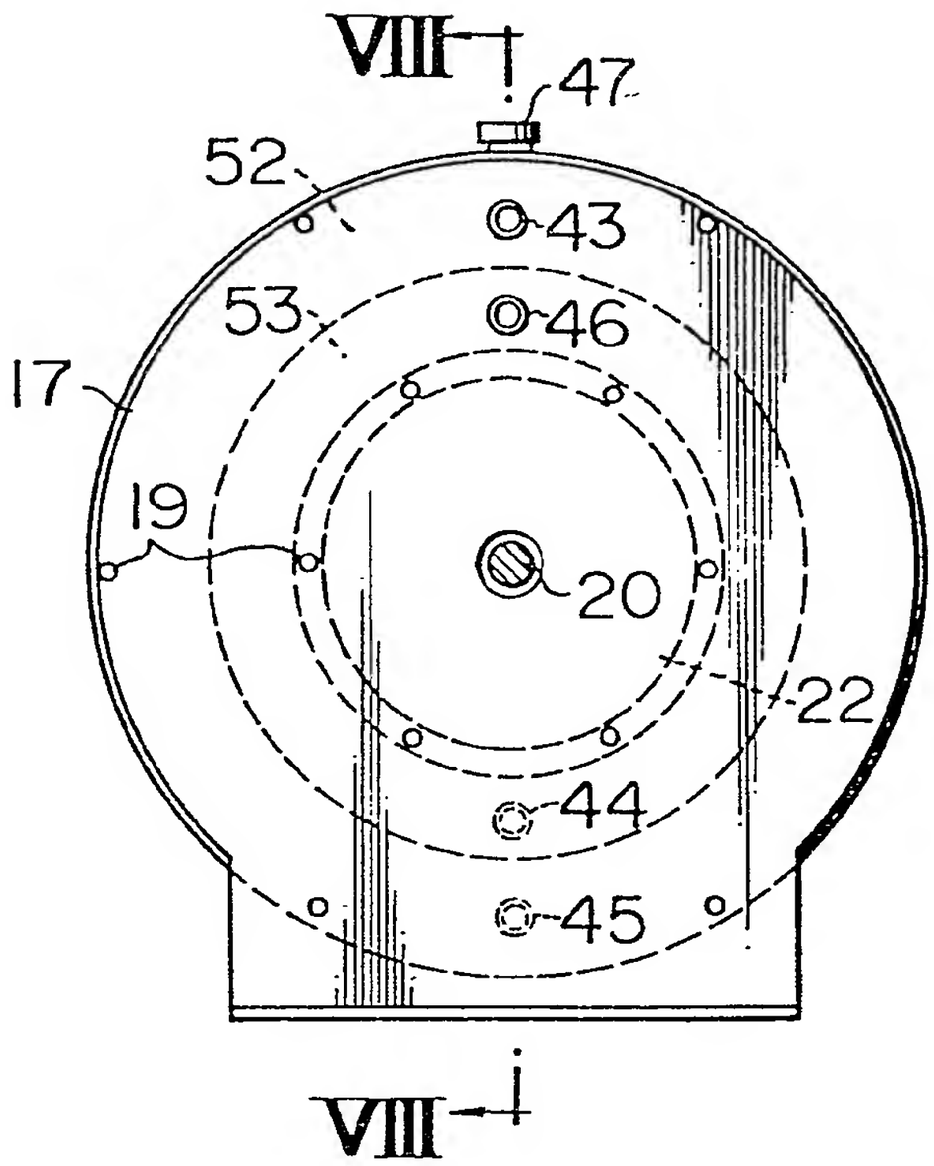
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FIG. 8

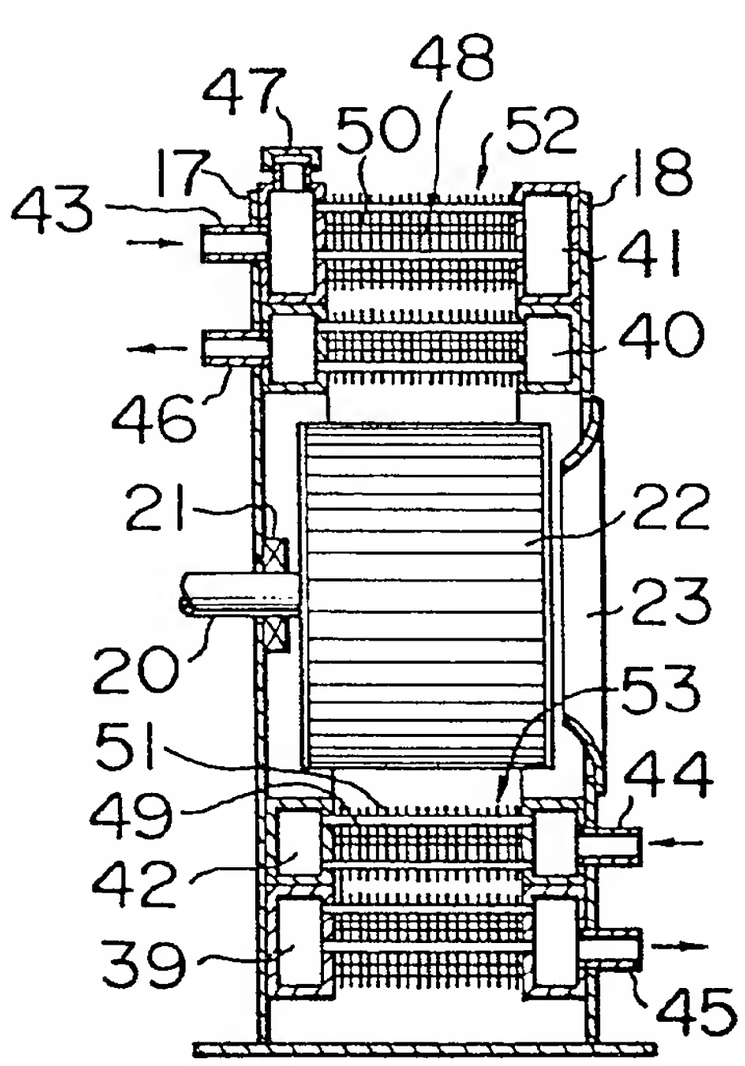
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FIG. 9

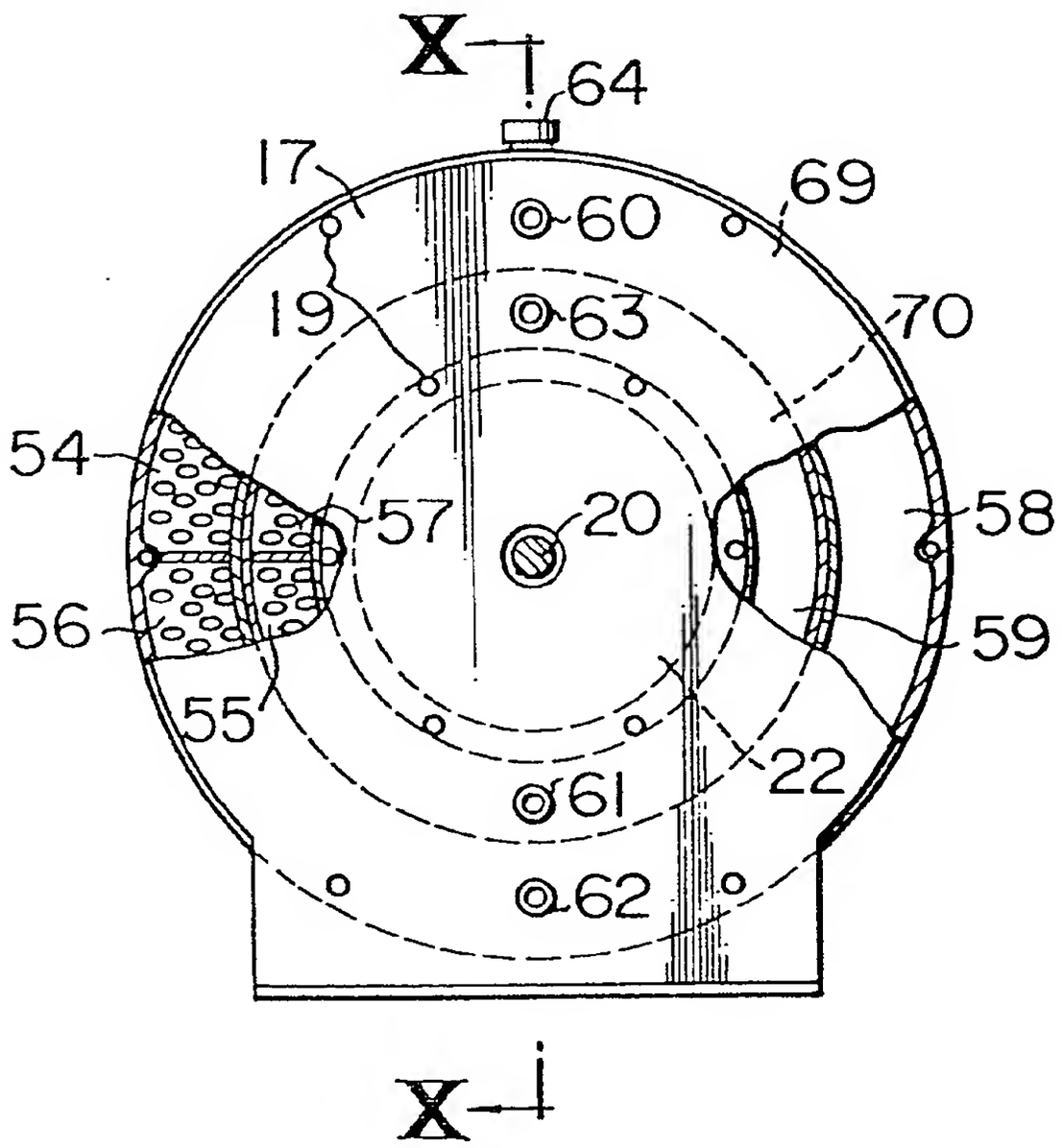
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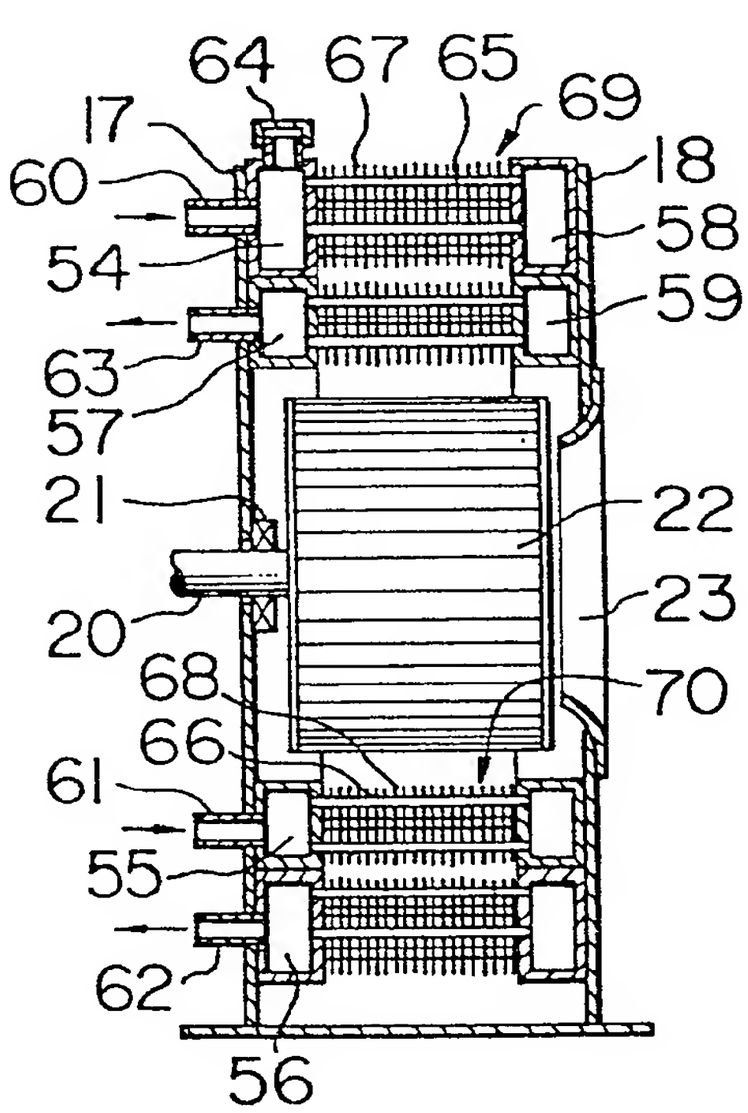
FIG. 10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European Patent Office

0036213

Application number

EP 81 10 2011

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	US - A - 2 171 817 (WAGNER) * Page 2, right-hand column, line 23 - page 3, left-hand column, line 74; figures 1,2,3,6 * --	1,2,3	F 28 D 1/04
	US - A - 2 260 594 (YOUNG) * Page 1, left-hand column, figures 1,2,3 * --	1,2,3	
	US - A - 3 642 062 (EDMAIER) * Column 2, line 24 - column 3, line 32; figures 1,2 * --	1,2,3	TECHNICAL FIELDS SEARCHED (Int. Cl.³) F 28 B F 28 D F 01 P
	GB - A - 260 357 (FORGAN-POTTS) * Page 1, line 78 - page 2, line 7; figures 1,2 * --	1,2,3	
	DE - C - 255 444 (SCHMID) * The entire document * --	1,4,5	
	US - A - 1 390 899 (FROELICH) * The entire document * --	1,4,5, 6	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E. conflicting application D: document cited in the application L: citation for other reasons
	FR - A - 557 583 (ARMAND) * Page 3, line 101 - page 4, line 64; figures 9-16 * --	4,5,6	
A	US - A - 3 800 866 (IRELAND)	1	&. member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26-06-1981	SCHOUFOUR

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 81 10 2011

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	FR - A - 515 625 (DUBIEF)	1	
A	DE - A - 2 718 966 (HARVESTER)	1	
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